

1. INTRODUCTION

1.1. Research background

In developed countries, nutrition-related diseases are increasing due to higher energy intake than what is required and low intake of dietary fiber (Rodríguez-García et al., 2012). In the United States of America, the prevalence of obesity increased from 31.2% in 2010 to 33.7% in 2014. It has led the society to prefer low-calorie food so they can meet their maximum daily energy intake goal. Responding to consumer demand, food industries start to produce food products which contain the least calorie possible by replacing the fat content with other low calory constituents. As fat's energetic value is 9 kcal/ g which is higher than other food constituents such as carbohydrate or protein, which value are 4 kcal/g, replacing fat might be a promising way for the food industry to trim the calorie content (Zahn et al., 2010).

Once associated with high-income countries, obesity is now also prevalent in low- and middle-income countries. In Indonesia, obesity prevalence was 4.3% in 2010 and became 5.7% in 2014 (WHO, 2016). This fact raises a question on the continuing development of fat replacers that did not give significant impact on the obesity and diabetes problems. It is acknowledged that obesity and nutrition-related disease may have many influencing factors but fat intake is one of the key factors that directly linked. World Health Organization defines obesity as an abnormal or excessive fat accumulation that may impair health. Obesity is the result of energy imbalance between calories consumed and calories expended due to change in dietary and physical activity patterns. The global trends are the increased intake of energy-dense food that are high in fat and decrease in physical activity due to the increasingly sedentary nature of many forms of work and changing modes of transportation. Obesity itself became one of the strongest risk factors for type 2 diabetes, which the number of patients had nearly doubled between 1980 and 2008 (World Health Organization, 2016). The dietary recommendation issued by WHO and FAO (Food and Agricultural Organization) state to limit saturated fatty acid intake to less than 10% of total energy intake in purpose to prevent diabetes.

Those who demand low calorie even zero calorie food can be considered as a health-conscious consumer. They are driven by the fact of the increasing number of obese and cardiovascular diseases that have a correlation with fat intake yet they do not want to sacrifice their psychological satisfaction upon tasty food (Brien & Mueller, 2003; Ognean et al., 2006). This becomes a challenge to replace the fat content while obtaining a good palatability since fat is responsible for texture, mouth-feel and flavor (Zahn et al, 2010). Akoh (1998) addressed this issue by showing the characteristics of fat replacers that can be used to reduce calorie on food products and summarizing on the sensory properties and rheology.

Various studies had been conducted to evaluate the effect of fat replacers on rheological properties and sensory evaluation of muffin (Martínez-cervera et al., 2015; Zahn et al., 2010), cakes (Kocer, 2007; Rodríguez-García et al., 2012), cookies (Zoulias et al., 2002), biscuits (Aggarwal et al., 2016; Sudha et al., 2007), ice cream (Ban et al., 2009) and other bakery products (Turabi et al., 2008). Those mentioned researches were conducted in the context of developed countries and researches are still rare in developing countries. Even though a couple decades had passed, the issues still remain the same, but the challenge now is how far fat replacers can fulfill the role of fat in food products with similar acceptance and preference by consumers (Aggarwal et al., 2016; Martínez-cervera et al., 2015; Sudha et al., 2007).

Data reported by Grand View Research, Inc. (January, 2007) shows that global fat replacers market is projected to reach USD 2.79 billion by 2025. It is caused by the increasing occurrences of obesity, cancer and cardiovascular diseases that urge consumers to lower their calorie intake. The Asia Pacific's market is expected to be the witness of faster growth and hold the largest market share by 2025, because of the increasing investments in food and beverage manufacturing industry related to this issue. Some companies that operate in this market are Cargill Incorporated, FMC Corporation, Archer Daniels Midland Company, Ashland Global Holdings Inc., Kerry Group PLC., DKS Co Ltd., and Agritech Worldwide, Inc. (www.grandviewresearch.com, 2017).

According to previous studies, it was clear that issues of obesity and related diseases had driven a consumer segmentation toward food products that can address their fat intake problem yet still give satisfaction. Fat replacers have been widely studied in developed countries as the solution to those issues but not in developing countries. Products that use fat replacer itself were rarely found in Indonesia. Indonesia as one of the biggest country in Asia whose consumers' characteristic can be a representative of developing country's consumers in Asia. Besides the reason of obesity and other nutrition-related diseases that also happening in developing countries, data reported by Grand Review Research show potential of this kind of products and how much the profit in the future, made this issue more interesting. Since there is no review yet on consumer attitude toward food products that contain fat replacers in the formulation in developing countries, this study tries to address the developing country's consumer characteristics in order to start further development of fat replacers so it can be implemented well in the future Indonesia market.

1.2. Introductory Literature Review

1.2.1. Fat Replacer

Fat is the densest macro nutrient providing 9 kcal/g compared to 4 kcal/g of carbohydrates and proteins. Fat as the food component has many contributions toward sensory and organoleptic properties such as taste, mouth feel, palatability and also flavor as they are lipophilic flavor compounds carrier that act as the precursor for flavor development (Ognean et al., 2006). Fat replacers are called so because they either indigestible or gave lower calorie contribution on a per gram basis toward the diet. Generally, fat replacers are categorized into fat substitutes and fat mimetic (Akoh, 1998; Ognean et al., 2006).

Fat substitutes are lipid based replacer that either chemically synthesized or derived by enzymatic modification from triglycerides that commonly stable at high temperature. There are three commercial fat substitutes, there are Olestra, Salatrim, and Caprenin (Akoh, 1998). Olestra is a trademark for sucrose polyester of 6-8 fatty acids, which are indigestible and zero calorie content suitable for savory snacks (Ognean et al., 2006). Olestra molecule size is large, made it has the ability to pass through gastrointestinal due to its fatty acids crowdedly surround sucrose core, therefore digestive enzyme cannot find

the breaking point in order to metabolize it into smaller pieces and absorbed by the body (Sandrou & Arvanitoyannis, 2000).

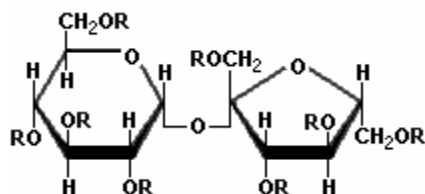


Figure 1. General Structure of Olestra

Salatrim, an abbreviation for Short And Long Acyl Triglyceride Molecule, is a group of structured triacylglycerols that provide the physical properties of fat, but only 5 kcal/g (Sandrou & Arvanitoyannis, 2000). Its functional properties such as melting points, hardness, and appearance in confectionery, provide cohesiveness, replace shortening and prevent starch retrogradation in baked goods and stabilize dairy desserts (Ognean et al., 2006). Salatrim is stated as GRAS (Generally Recognize as Safe) by FDA in 1994 after Nabisco Foods Group who manufacture and market it with brand name Benefat™ submit a petition (Akoh, 1998). Caprenin / caprocapylobehenic triacylglyceride is a low energy fat compound and comprises of caprylic, capric and behenic acid (Sandrou & Arvanitoyannis, 2000). Caprenin is intended as the cocoa butter substitute in soft candy and confectionery coatings (Ognean et al., 2006).

Fat mimetic is carbohydrate or protein based replacer that had been modified to mimic fat organoleptic properties (Akoh, 1998; Ognean et al., 2006). Commonly fat mimetic plays role as a stabilizer and textures to provide the mouthfeel. The only protein based fat substitute approved by FDA is Simplesse. It is a microparticulate protein derived from egg white, skim milk and protein to provide fat-like mouthfeel and lowering consumer dietary fat without sacrificing sensory quality (Sandrou & Arvanitoyannis, 2000). Simplesse is round in shape and uniform particle commonly used to stabilize or emulsify yogurt, cheese and sour cream (Ognean et al., 2006).

The example of carbohydrate based fat mimetics are gums (guar, xanthan, locust bean, carrageenan, gum arabic, pectin), cellulose (microcrystalline, powdered, methyl-, hydroxypropyl methyl-), maltodextrin, polydextrose and β-glucan (Akoh, 1998; Ognean

et al., 2006). Those gums were obtained by extraction or fermentation. Guar-, xanthan-, and locust bean gum are used for baked goods in order to retain moisture and retard staling (Ognean et al., 2006). Carrageenan and arabic gum are used for salad dressing to provide mouthfeel, increase viscosity and textures while pectins usually used for sauces as a thickening agent (Ognean et al., 2006). Cellulose commonly processed chemically except microcrystalline that obtained by chemical grinding. Each kind of cellulose has the ability mimic the fat characteristic in baked goods, dressings, and frozen desserts. For further information about the application of fat replacers was reviewed by Akoh (1998) and Ognean et al., (2006).

1.2.2.Fat Intake and Obesity

Nutrition and Metabolism Advisory Committee (2003) did an evidence-based review that was presented to National Heart Foundation of Australia Cardiovascular Health Advisory Committee (CVHAC). This review was developed through an extensive review and consultation process by a working group then reviewed and revised based on the committee members' comments. They reviewed papers and many reports and categorized them as evidence from epidemiological studies, mechanisms of dietary fat absorption in the body and interventions studies to understand the relationship between dietary fat and overweight/obesity. In their conclusion, the energy density is the major determinant toward a fat intake that led to obesity besides many other factors such as physical activity, habit, genetic etc. Energy density is the amount of energy (calories) per gram of food. Lower energy density means less calories intake per gram of food. The examples of low energy density foods are the ones that have high water content such as soups, pasta (absorb water during cooking), fruits, vegetable, and fiber. Fat stimulates people to overconsume it through its high palatability and lack of satiety power that may lead to obesity. Therefore, researchers are consistent with the view that the increase in fat intake may put a significant fraction of the population at risk of obesity, especially those who are genetically predisposed to the condition (Bray et al., 2004). Based on USDA dietary guideline 2015 – 2020, people are encouraged to consume less than 10 % of calories per day from saturated fats.

One study reported that many of the United State's undergraduate college students have insufficient physical activities and unhealthy food choices (Lowry et al., 2000). In that year they are fully aware of overweight and obesity issue that may lead to mortality and morbidity related to chronic disease. The nation set objectives to overcome those problems with fostering healthy diet behavior and physical activity includes increased fruit and vegetable consumption and reduced dietary fat consumption. According to Riskesdas (Basic health research) 2013, obesity prevalence in Indonesia is 26.6 %, it is higher than it was in 2007 at 18.8%. The highest prevalence is in Jakarta (39.7%) and there are some province that the rate is above national average such as East Java, Bali, Yogyakarta, Sumatera Barat and the other. But Central Java is not included.

1.2.3. Health-Conscious Consumer

Consumers are classified into segments where their demand functions can be distinguished from the total market demand. Marketing segmentation research focuses on the bases and method where segmentation basis refers to characteristics or set of variables that can be used to assign customers into a homogeneous group while segmentation methods refer to the type and number of segments (Bressolles et al., 2014). Consumers have been known to take a more conservative stance toward new processing methods in food production while food scientist applauds the progress of science (Perrea et al., 2015). Socio-demographic has a relation to consumers' food choices where in particular, high income and education levels prefer low-fat foods and high fiber foods while the other associated with high energy intake (Casini et al., 2015).

Lappalainen & Gibney (1998) reported the characteristics of the European Union's consumer at that time believed that eating less fat is a part of a healthy diet. Consumers rely on health professional's advice about how good diets supposed to be. When at that time, nutrition educators in Europe advised the dietary changes to decrease fat intakes and increasing fruits and vegetables. It is known, people who attending university had a better understanding on dietary guideline rather than less educated people and the older. Unfortunately, those people had a barrier as irregular working hours as the obstacle to follow dietary guideline diligently.

Health consciousness is a state when a person concerns about their wellness by improving and maintaining their life quality through healthy habit (Kaynak & Ek, 2014). Health-conscious consumers are the one who strives for healthier alternatives for consumption. When individuals have a higher level of health consciousness, they set up their lifestyle and preferences to support their well-being; therefore they are prone to consume less for their wellness (Kaynak & Ek, 2014). Health consciousness was measured with the different approach and applied the concept in diverse health-related issues that most of them used actual behavior such as food consumption, substance use, and exercise as the tools (Hong, 2009). In summary, there is a difference in conceptualizing and measuring health consciousness among scholars. According to Hong (2009), health consciousness concept consists of five major dimensions: (1) engagement in health behaviors, (2) psychological attention to one's health, (3) health information seeking and usage, (4) personal responsibility, and (5) health motivation. Generally, health-conscious persons are those who actively implementing healthy behaviors in daily routines, being consistent in monitoring their health condition, actively seeking and using health information from various sources, being responsible for their health and motivated to stay healthy.

However, in the current study, it is more necessary to measure it based on psychological traits of the concept rather than indirectly measured using visible behavior. Hong (2009) had developed a scale for measuring health consciousness with a new re-conceptualization of it. He concluded that health-consciousness is not related to specific issues such as exercise, smoking or healthy diet, but refers to the individual's comprehensive mental orientation to their health, being comprised of self-health awareness, health motivation, and personal responsibility.

According to Ellulu (2014), the prevalence of overweight and obesity has shown an increasing trend along with other cardiovascular risks as a global epidemic. In the urban areas, overweight and obesity are common cases rather than in rural areas. World Health Organization (WHO) states the global burden for the next decade is chronic NCDs (Non-Communicable Diseases) as the trend increases year by year. By 2020, the burden's proportion of NCDs will tend to increase to 57%. WHO predicts obesity will be a serious problem throughout Asia, Latin America and parts of Africa, despite under nutrition

problem. The developing countries will face a double burden situation where under-nutrition and over-nutrition take a place. Hoffman (2001) explained that poverty and obesity are causal, where poverty leads to poor nutrition because it reduces the ability to purchase nutritious food when the obese earns and consumes more. Therefore the low quality of food (low in good nutrition) may lead towards weight gain. With such overweight / obese, their movement is limited, and it limits their work capacity that eventually returns them to a state of lower income. Another cause is an urbanization that happened in developing countries. Once the urban stay in the city, their habit of making their own food changes to purchase processed food as this phenomenon referred to “western diets”. It has been reported to be associated with chronic disease, diabetes, excessive calorie intake and obesity (Hoffman, 2001).

1.3. Research Questions

After seeing the potential of fat replacer in the food product, this paper will try to answer the questions why this technology is not implemented yet in developing countries especially in Semarang, Indonesia as a case study. When there is a demand for food products that use fat replacer in the market but the availability of the product is very limited, it is important to identify the factors that may influence this condition.

To answer the question, this paper will discuss:

- The characteristics and the development of fat replacers by literature review.
- To see market potential by surveys which reflect the Indonesian market's health consciousness, attitude, and demand toward products that use fat replacers.
- Analyzing the factors which may cause the delay in the technology implementation i.e. price, safety and sensory evaluation of survey and literature review.

1.4. Objectives

The objectives of this paper are to review the development of research of fat replacers, to study the consumer attitude, preference and consideration in purchasing food products with fat replacers formulation.